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Recommended Citation
Rückeshäuser, Nadine, (2017). "TYPOLOGY OF DISTRIBUTED LEDGER BASED BUSINESS MODELS". In Proceedings of the 25th European Conference on Information Systems (ECIS), Guimarães, Portugal, June 5-10, 2017 (pp. 2202-2217). ISBN 978-989-20-7655-3 Research Papers.
http://aisel.aisnet.org/ecis2017_rp/140

TYPOLOGY OF DISTRIBUTED LEDGER BASED BUSINESS MODELS

Research paper

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Abstract

The potential of distributed ledger technology and its application in various industries is a controversially debated topic. Advocates of the technology emphasize the economic benefits of decentralization and transparency, leading to cost reductions as well as the alleviation of several of today`s economic and technological problems. In contrast, critics assert that the potential of distributed ledgers might be overhyped, possibly leading to the next tech bubble. This paper contributes to the discussion by developing a typology of business models that are based on distributed ledger technology. In particular, this paper is a first step towards a more differentiated discussion on the potential of distributed ledges, by taking the underlying business models into consideration. Despite a characterization of the types, a discussion about special features of distributed ledger based business models is provided in the context of contemporary business model literature and the associated role of IT. It is proposed that future research must evaluate each business model isolated to achieve a comprehensive assessment of the potential of distributed ledgers. This paper can be interpreted as starting point for more fruitful discussions and the repeal of the partially diametrical opposed opinions towards the potentials of the technology.

Keywords: Distributed Ledger, Business Model, Typology, Potential Analysis

1 What is the Future of Distributed Ledger Technology?

Distributed ledgers can be described as decentralized trust-technology, which enables transparent and secure transactions between nodes in a distributed network. The technological features of these ledgers facilitate business models based on smart-contracts, leading to disintermediation and potentially increased protection against data manipulation due to the automated enforcement of digital properties of contracts. Potentially, this paradigm shift in the management and storage of data implies losses of competitive advantages for big players employing data-centric business model (Wittpahl, 2016). Despite the 'democratisation of data' on distributed ledgers (Wittpahl, 2016), one of the most controversial discussed issue is the disruptive force of distributed ledgers for the financial sector and, especially, its consequences for the reliability and efficiency of trade finance and post-trade processes (Pinna and Ruttenberg, 2016). Besides that, various other application areas were identified over the past years, including the usage of non-corruptible distributed ledgers for land rights (Sixt, 2016) or the application of the technology for corporate governance (Yermack, 2015). Given the abundance of potential application areas as well as an increasing amount of venture capital invested into the distributed ledger market, it is not surprising that first voices are being raised, questioning whether the potential of distributed ledger technology might be overestimated and if the market evolves to the next tech bubble (McMillan and Jackson, 2015; Valenzuela, 2016). According to own research, these concerns are also shared by the industry and enterprises build on distributed ledger technology. For instance, Dr. Gideon Greenspan, Founder and CEO of MultiChain, a software platform for deploying blockchain-based applications, indicated that the potential of blockchains is overestimated and overhyped, particularly in the financial sector. Similar Evans-Greenwood et al. (2016) argue that a few years ago, advocates of cloud computing seem to assert that any problem could be fixed or at least alleviated by moving it into the cloud. One might claim that, today, we are hearing the same refrain with 'into the cloud' replaced by 'on the blockchain' (Evans-Greenwood et al., 2016).

In the context of this controversial debate, this paper asserts that the application of distributed ledger technology may be justified by its possible economic benefits; however, in order to quantify its potential a more differentiated discussion is necessary. Notably, the potential of distributed ledger technology may manifest itself in different ways and strengths, among others, depending on the industry and the value proposition provided by businesses. Before the potentials of distributed ledgers are discussed, it is therefore necessary, first to identify the emerging business models based on this technology. Hence the overarching research question is: Which distributed ledger based business models can be currently observed and how can they be characterized? To this end a typology of business models based on distributed ledgers is provided, using previously identified parameters, for a subsequent characterization and comparison of distributed ledger based business models.

Contribution: This paper identifies emerging business models related to distributed ledger technology and conducts a typification. Despite the typology cannot claim generality as well as completeness given the early state of research on distributed ledger based business models, the implications may be relevant for scientists a well as practitioners. First, the typology and subsequent characterization of business models strengthens the academic discourse in the sense that it delivers a starting point for a more differentiated discussion on the potentials of the technology that are expected to differ depending on the underlying business model. Furthermore, a special focus is placed on a corporate view on the technology use, which is neglected in the current academic discussion, which is predominantly concentrated either on the technological as well as economic foundations of distributed ledgers (e.g. Böhme et al., 2015) or the analysis of concrete distributed ledger applications, such as cryptocurrencies (e.g. Kazan et al., 2015). Second, for practitioners this typology delivers a framework for business orientation and guidance, especially in regard to characteristics that businesses may have to consider, if they want to start a distributed ledger based business, including considerations on how to differentiated themselves from other contemporary IT-enabled business models.

The paper is structured as follows: The next section briefly discusses the terminologies bitcoin, blockchain, and distributed ledger technology and identifies different types of distributed ledgers, on which basis divergent business models emerge. Subsequently, a case study of business models based on distributed ledgers is conducted using the concept of a business model as well as its key features that are identified for the purpose of this study and that serve as theoretical foundation. A questionnaire was used to capture the business models of 150 businesses based on the technological features of distributed ledger technology, whereas the results of this study are presented in section 3. The case studies are used as references to create a typology in the following section. Despite the application of the approach of empirically grounded type building, a morphological box is used to present all possible combinations of dimensions and attributes identified in the empirical study, which serves as foundation for the type building process. Section 4 presents the identified types of business models, exemplified by concrete business cases. Afterwards these business models are discussed and compared in the context of contemporary literature on business models. Finally, a conclusion and outlook is provided.

2 Bitcoin, Blockchain, and Distributed Ledger Technology

A distributed ledger is a database, maintained and shared between nodes in a peer-to-peer network. Nodes are equal and possess an identical copy of the distributed ledger, whereas changes in the database are reflected immediately and are incorporated by consensus between all participants, which is a primitive in distributed computing (Dolev et al., 1983). Consensus is found in accordance to prespecified rules, agreed on by the network (Walport, 2015). The ability to find consensus in a peer-to-peer network and to validate data that will be incorporated into the distributed ledger through the network, implies that there is no need of a third party, leading to disintermediation as well as increased transparency, which is a prerequisite for decentralized validation (Evans-Greenwood et al., 2016). Ultimately, this form of consensus implied by distributed ledgers, enables decentralized and autonomous business models, based on the execution of Turing-complete codes for so-called smart-contracts that are automatically enforced contracts, leading to safe fulfilment of digital properties and compliance, respectively (Vukolic, 2016).

Distributed ledgers evolved originally from the world of virtual currencies and decentralized payment systems, of whom Bitcoin is the most prominent example (Pinna and Ruttenberg, 2016). The distributed ledger underlying Bitcoin is called 'blockchain', which ensures transactions to be aggregated chronologically in so called blocks and added to a chain of existing transactions using cryptographic signatures (Fanning and Centers, 2016). New blocks are referenced to the preceding block by using hash values, meaning that blockchains represent a history of information stored on it and the chronological ordering of information constitutes an inherent feature of blockchains (Taylor, 2013). The integrity and security of data is provided by so-called 'miners' that exert effort to validate and store information on the blockchain, whereas generally, every node in the Bitcoin network could be a miner provided that the node has the right and capability to expense a sufficient amount of effort (Walport, 2015). Despite the distributed ledger applied by Bitcoin, several other types of distributed ledgers exist that may provide different characteristics than blockchains that offer automated chronological storage and, consequently, facilitate different applications that Bitcoin. The reason for the existence of different types of distributed ledgers is that the technology offers various technical design options, including the decision whether or not information is stored chronological as well as whether or not access to the underlying peer-to-peer network is the open. Table 1 depicts the technical design decisions of distributed ledgers and presents examples of distributed ledger types in use.

Data Storage / **Network Access**	**Inherent chronological order**	**Non-chronological order**
Permissionless network	Type i. *Example: Bitcoin* (Nakamoto, 2008), *Stellar* (Mazières, 2016)	Type ii. *Example: BigchainDB* (Mcconaghy et al., 2016)
Permissioned network	Type iii. *No example available (not practicable?)*	Type iv. *Example: R3 Corda* (Brown, 2016)

Table 1. Design Decisions and Types of Distributed Ledgers

Whereas distributed ledger of type i. can also be used for other applications than Bitcoin (e.g. for alternative payment networks), a historical transaction record must not necessarily back distributed ledgers, i.e. distributed ledger type ii. and iv.. For example, the Corda platform is a distributed ledger for recording and processing financial agreements by supporting smart contracts. According to the Corda whitepaper, however, despite the distributed ledger is inspired by the blockchain, it does not include particular design choices that are typical for blockchains, i.e. chronological ordering (Brown, 2016). Another design decision related to distributed ledgers is concerned with the scope of the network and network access, respectively. In particular, the size of the network, which is the number of participating nodes, depends on whether the ledger is restricted or unrestricted. Restricted, also called permissioned or private ledgers, limit the number of nodes using specific gatekeeping mechanisms, whereas unrestricted ledgers, called public or permissionless ledgers, allow anyone to participate (Pinna and Ruttenberg, 2016). In principle, any combinations in the matrix presented in Table 1 as well as hybrid forms are conceivable. Nevertheless, in practice, distributed ledgers of type ii. and iv. seem to feature either permissioned or permissionless access, whereas type i. distributed ledger typically feature permissionless access. Accordingly, no application of type iii. distributed ledgers are known to the author so far, which might imply that this combination of design features is not practicable (Bitfury and Garzik, 2015). It is presumed that the lack of type iii. ledgers may result from the fact that chronological ordering is most often associated with mechanisms that imply the exertion of effort and resources, such as computer power, to integrate information chronologically into the ledger. Assuming that permissioned networks are most likely applied in a corporate context, e.g. if a company wants to maintain a privately hold ledger, the expense of resources may be in contrast to overall corporate objectives such as profit maximization and the economically use of resources.

Despite different types of distributed ledgers can be identified based on these design decisions, a consensus protocol, responsible for the validation of transactions, lies at the core of each type. In particular, consensus protocols allow machines to work together as a group that can survive even if some of its members fail. The concrete choice of a consensus protocol depends on requirements like performance, scalability or security (Seibold and Samman, 2016) as well as on the concrete design decisions regarding network access and the ordering of stored transactions. For example, permissionless distributed ledgers typically feature consensus protocols that avoid censorship and counterparty exposure by setting incentives to hold the majority of the network nodes honest, e.g. by introducing the concept of mining (Nakamoto, 2008). On the other hand, private distributed ledgers may apply other consensus protocols as nodes are legally known and identified to validate transactions. Particularly, this reduces the need for proof, such as in the Bitcoin system and consensus can alternatively be found by bilateral consensus, e.g. such as in the case of the Corda platform (Seibold and Samman, 2016).

The described design decisions and the associated choice of a suited consensus protocol, imply great flexibility, which opens up the possibility of various application areas. Generally, distributed ledgers of each type have the potential to radically overhaul existing business models that are based on long chains of intermediaries, which are needed to prevent market failures or principal-agent problems, associated to uncertainty and risks (Probst et al., 2016). From an economical viewpoint, the hereby induced disintermediation as well as increased transparency leads to significant cost reductions, especially in regard to transaction or monitoring costs (Pinna and Ruttenberg, 2016). The overarching economic benefits of distributed ledgers for various applications reasons the following analysis of business models based on this technology without differentiating between the actual types employed.

3 Business Models based on Distributed Ledgers

Key features of business models are identified by means of a literature review. Then, a case study of distributed ledger based business models is conducted to investigate the fulfilment of these features.

3.1 The Business Model Concept and Key Components

Although the concept of business models has been extensively discussed in the literature, there is still a lack of consensus on what comprises a business model (Hedman and Kalling, 2003; Morris et al., 2005; Kujala et al., 2010). This is mainly because the concept of business models aims to combine a variety of different views, such as the perspective of industrial organization (Porter, 1980), a resource-based view (Peteraf, 1993) or the perspective of strategic process (Chakravarthy and Doz, 1992). Consequently, before a typology of business models based on distributed ledger technology can be developed, first, a definition as well as associated concepts must be identified for the purpose of this paper. Moreover, the hereby-derived definition is used in the questionnaire, to capture the following case studies and business models in a most comprehensive way.

On a most basic level a business model can be defined as a method of doing business by which a company sustains itself and positions itself in the value chain (Chesbrough and Rosenbloom, 2002; Baden-Fuller and Morgan, 2010). This generic description can be proliferated by specifying features of a business model. In this paper, the selected features are based on the comprehensive overviews provided by Morris et al. (2005), Chesbrough and Rosenbloom (2002), Kujala et al. (2010) as well as the practical approach of business model generation proposed by Osterwalder and Pigneur (2010). In order to identify the relevant key features, the characteristics of business models identified in the respective works were compared and similar concepts were summarized to six general categories. Key features were only used if they were mentioned in the majority of works. For instance, a key features that was only mentioned by one study was consequently omitted from this analysis. Furthermore, the identified key features are also comparable and in accordance to the components of business models identified by the work of Hedman and Kalling (2003) as well as Al-Debei and Avison (2010). The resulting six features of business models are presented and described in the following:

- **Customer value proposition:** A business model should solve an important problem or fulfil an important need for a target customer, by offering an appropriate product or service (Johnson et al., 2008). The value of a technology will be mirrored by the willingness to pay for an offered product or service (Chesbrough and Rosenbloom, 2002). The inclusion of the value proposition as business model feature is supported, among others, by Afuah and Tucci (2001), Alt and Zimmermann (2001), and Chesbrough and Rosenbloom (2002).
- **Identification of a market segment:** The market segment includes users to whom the offered product or services is useful and defines the purpose. On this basis revenue generation mechanisms are specified that also rely on the customer types, geographic dispersion, and their interaction requirements (Chesbrough and Rosenbloom, 2002; Morris et al., 2005). This feature of the business model is emphasized by, among others, Markides (1999), Gordijn and Akkermans (2001), and Chesbrough and Rosenbloom (2002).
- **Estimation of the cost structure and profit potential:** A business model must provide a consistent logic for earning profit (Morris et al., 2005). This implies questions such as, how will the customer pay and how much to charge. If the business acts within the Internet, payment models are numerous, reaching from charging by transactions, licensing, or selling after-sales supports and services. At the same time the pricing strategy must consider the cost structure of a business (Chesbrough and Rosenbloom, 2002). The inclusion of costs and revenue structures is proposed by, among others Markides (1999) and Alt and Zimmermann (2001).
- **Positioning within the value network:** Positioning within the value network involves third parties within the vertical value chain as well as from the value network. A business must establish relationships with suppliers, partners, and customers, through which it can achieve complementary goods, increase network effects, and leveraging effects on the value of IT. The positioning in the value network involves thinking about where value is created for the customer with respect to the value chain (Chesbrough and Rosenbloom, 2002). The inclusion of this feature is emphasized by Gordijn and Akkermans (2001), Hamel (2001) and Chesbrough and Rosenbloom (2002).
- **Definition of the structure of the value chain:** To define the structure of the value chain, offerings must be created and distributed. This also includes the determination of complementary assets needed to support the businesses position in the value chain (Chesbrough and Rosenbloom, 2002). Notably, a superior structure of the value chain could lead to competitive advantage through the successful management of the interface between the business and others in the value network (Morris et al., 2005). This feature is proposed among others, by Afuah and Tucci (2001) and Chesbrough and Rosenbloom (2002).
- **Formulating a competitive strategy:** A business model includes the formulation of an appropriate competitive strategy, delineating how the company intends to achieve advantages over competitors by identifying differences that can be maintained and mitigate on-going development. This requires thinking about the core competency, helping a business to perform relatively better than others (Morris et al., 2005). This feature is proposed by, among others, Weill and Vitale (2001), and Chesbrough and Rosenbloom (2002).

3.2 Case Studies and Representation of Selected Business Models

To perform the following empirically grounded typification, a case study was conducted focussing on corporations, deploying business models based or focussing on distributed ledgers. Using the information from the databases *Blockchain Technologies*, *Crunchbase* and *AngelList*, in total, 150 corporations were contacted and asked for information using a questionnaire, which captures the previously identified six key features of a business model. No pre-selection of companies in regard to business lifecycle positioning, geographical aspects or industry affiliation was done in order to avoid biases. Instead, companies were contacted in accordance to the degree of attention they receive, which was approximated by the number of followers on *AngelList*. A list of all companies that were contacted, descriptive statistics on the companies geographical location, industry affiliations as well as the questionnaire feedback is retrievable under the following link: http://bit.ly/2dbmygH.

Out of 150 contacted companies, 6% answered the questionnaire, 1% provided additional information on the company and 4% rejected to give any answers in a time period of 3 months, starting in August 2016. Deducted from the justifications received from the companies that reject to answer the questionnaire, it is assumed that companies that did not react are either not willing to disclose information of their business model, e.g. if they not yet launched their products or services, or due to time constraints. Moreover, it must be considered that start-up markets are typically volatile and some companies and, especially, companies that were in their early stages at the time they were contacted, may no longer exist. Table 2 provides an overview of the companies that answer the questionnaire (small companies: up to 10 employees, middle-sized companies: up to 50 employees).

Company Name	Industry	Company Size	Location
MultiChain	Infrastructure	n/a	UK
Singular	Property Rights	Middle	USA
Uniquid	Identity Management	Small	USA
SETL	Finance	Small	UK
DXMarkets	Finance	Middle	Singapore
Symbiont	Smart Contracts	Middle	USA
Factom	Infrastructure	Middle	USA
Fuzo	Payment	Middle	China
VARcrypt	Property Rights	n/a	USA
Provenance	Business Applications	Middle	UK
StingLabs	Infrastructure	Small	UK

Table 2. Overview of companies disclosing information on their business model

Some of the companies indicated in Table 2 did not reveal certain types of information. Four companies did not reveal their strategically business relationships, three did not want to disclose information on the network positioning and two companies did not reveal information on both cost structure and/or competitive strategy. Despite business models seem to differ significantly at a first glance, during the review process also similarities became visible. In the following two business models will be exemplary presented focussing on features with the greatest identified differences. This limited representation is mainly done because of space restrictions. An overview over the complete information on business models provided by the companies is available under the following link: http://bit.ly/2dbmygH.

CASE STUDY 1: UNIQUID

UniquID is a software provider trying to solve the increasing challenges associated with the Internet of Things and growing interconnectedness of smart devices. UniquID provides device-centric solutions that recognized users through personal connected objectives, thereby removing the risk of user-generated passwords. Moreover, appliances that serve lightweight trusted node services are offered that are built to run on virtual machines or workstations inside a company's infrastructure. By hosting a proprietary blockchain infrastructure, smart contracts are kept decentralized, confidential and redundant (UniqueID, 2016). The company claims to reduce infrastructure complexity and eases the management of and interaction with devices and remote cloud services for big companies. UniquID generates profits by using Software-as-a-Service pricing strategy, through licensing and consulting services.

Business Model Feature	Description
Customer Value Proposition	- Software Provider removing the need of passwords to access digital systems - Eases the management and interaction of devices and remote cloud services - Reduction in infrastructure complexity - Higher pricing flexibility for customer tailored sales models due to blockchain
Market Segment	- Companies that need to manage hundreds or thousands of customers and/or need to connect things e.g. sensors, meters, vehicles, etc.
Revenue Stream	- Software-as-a-Service (SaaS) - Licensing - Minor revenue flow from consulting services
Value Network Positioning	- "B2B2B" - Service offered to system integrators or businesses

Table 3. Short Form Business Model Description UniquID

CASE STUDY 2: DXMARKETS

DXMarkets is a professional-grade exchange platform that provides liquidity for digital assets in high-grade secure and scalable environments. By integrating blockchain technology into enterprise-based financial processes, DXMarkets expects to increase efficiency and to reduce costs by growing operating margins and the generation of new revenue streams. Strategic consulting as well as smart contracts for customer-based modelling of digital instruments are also offered, e.g. for automated trades or coupon payments (DXMarkets, 2016). By this, DXMarkets addresses both private and institutional investors as well as businesses and positions itself as connector of demand and supply within the market.

Business Model Feature	Description
Customer Value Proposition	- Grade trading platform for digital currencies - Low latency trading, real-time charting, profit and loss sharing, bulletproof security - Increased efficiency and reduced costs by integrating blockchain technology into enterprise based financial processes
Market Segment	- Private/Institutional Investors - Businesses
Revenue Stream	- Commissions based on the transacted volume - 6% on sell-side, 2% on buy-side
Value Network Positioning	- Platform as connector of supply and demand side - Value capture at the point of transaction

Table 4. Short Form Business Model Description DXMarkets

4 A Typology of Distributed Ledger Based Business

In the following a typology of business models based on distributed ledger technology will be constructed based on the answers on the questionnaire and exemplified by selected businesses cases. Typologies are regularly used in management science and, especially, in the context of business models for example in Pugh et al. (1969) as well as by Kujala et al. (2010).

4.1 Creation of a Typology and the Concept of Types

A typology is a method for delineating types of things or events, where types are created conceptually, using a top-down approach as well as facts from experience and observation (Baden-Fuller and Morgan, 2010). By this, every typology is a result of a grouping process, where an object field is divided into some subgroups (types) with the help of dimensions and attributes (Doty and Glick, 1994; Kluge, 2000). In social sciences, these types are sometimes also referred to as 'ideal types' following Max Weber's notion of ideal types as generalisations mediating between ideas and theories. The method of empirically grounded type building is applied in this paper, following Kluge (2000) and

Charmaz (2006), taking advantage of the method's flexibility compared to other approaches for type building, e.g. Kuckartz (2010). Notably, empirically grounded type building allows for various analysing methods to reach the sub-goals, depending on the research question and quality of data (Kluge, 2000). Moreover, a four-step process for type building was applied according to Kluge (2000).

The first step of the empirically grounded type conduction process consists in *defining relevant dimensions and attributes*, which form the basis of the typology. Notably, dimensions and attributes are required to adequately grasp the similarities and differences between the identified business models and are finally needed to describe the resulting types (Kluge, 2000). Within qualitative studies, Keller and Kluge (1999) noticed that the definition of dimensions and attributes happens during the process of analysis of collected data and with the additional help of theoretical knowledge. Accordingly, the case study provides the dimensions, which are the business features as well as the associated attributes, which get apparent from the questionnaire answers. Afterwards, business models must be *grouped and analysed in regard to empirical regularities* by means of the defined dimensions and attributes. In this paper a morphological box (Zwicky and Wilson, 1976) represents all possible combinations, on which basis the distribution of the business models to these combinations must be proofed for internal and external heterogeneity. Notably, the morphological box is suited for this study as it is typically used for the structuring of a set of relationship containing multi-dimensional, non-quantifiable problem complexes (Ritchey, 1998). This analysis builds the foundation for type building and constitutes the second step of the typology building process (Kluge, 2000). Step three, consists in *identifying meaningful relationships and building types* through the combination of attributes. Notably, this also requires the building of new attributes and the repetition of step one to three for an empirically grounded type construction. After type building, a *characterization of types* must be conducted, using the types attributes or by using other criteria such assignments as ideal type or extreme type, etc. (Kluge, 2000).

4.2 Morphological Box for Distributed Ledger Based Business Models

A morphological box (Zwicky and Wilson, 1967) is developed and used as instrument to graphically represent the combinations of dimensions and options of business models (Table 5). The morphological box comprises step one and two of the type generation process. In a first step, all identified business model features were assumed as dimensions for the subsequent typology building process, assuming that the features identified in the previous section describe business models in comprehensive way, leading to an in-depth understanding of the detailed characteristics of the subsequently analysed business cases. Based on these dimensions, the information provided in the context of the questionnaires were analysed first individually and, afterwards, through the comparison of relevant keywords as well as associated and similar expressions. Examples for such keywords in the dimension customer value proposition are, among others, 'Platform', Infrastructure', 'Service', 'Distribution', which provided a first differentiation of the analysed business cases. Particularly, the hereby achieved conceptual elaboration of similarities and differences of the provided information related to the different dimensions, enabled the derivation of options for the particular business model features. The identified options are expected to fulfil the requirement of great external heterogeneity, meaning that the identified options must differ significantly. Dimensions, in which no significant divergences of options could be identified based on the answers provided by the companies, were excluded from the morphological box. Moreover, one additional option is added as a result of the general screening of the contacted companies' homepages. In particular, one characteristic was observed, which referred to the keyword infrastructure. Questionnaires, which contained this keyword, were platforms that allow for further development. However, during the screening it was observed that business that can be assigned to be infrastructure provider also supply databases or other infrastructures that do not offer additional functionalities for development. This observation was taken into account by adding one additional option called *infrastructure provision* to the dimension core value proposition. At the end, this leaves 4 dimensions and 18 options, which describe business models premised on distributed ledgers.

Dimensions	*Options*					
Core Value Proposition	Infrastructure Provision	Platform-Based Development	Application-Based Integration	Service/ Application Provision	Supporting/ Supplementary Services	
Market Segment	Software Developers	Big Businesses	Small and Medium-sized Businesses	Business End-Consumer	Private End-Consumer	Gov-ern-ment
Value Network Positioning	Before Transaction	During Transaction	After Transaction			
Revenue Stream	Transaction-Based	Revenue Sharing	Licensing & Consulting	Subscription/ Account-Based		

Table 5. Morphological Box for Distributed Ledger Based Business Models

The dimension *core value proposition* is divided into five options. The option infrastructure provider refers to businesses that provide distributed ledgers as mere data infrastructure, e.g. as database. Businesses that provide platform-based development provide a general infrastructure as well, but additionally allow for the development of applications or other features on top of their infrastructure. Application-based integration comprises services based on a proprietary infrastructure, to develop and integrate various applications and solutions suited to an organizational structure and demands of a particular business. The next option is service or application providers that offer 'ready to use' applications, for example, for accounting or management of property rights that can be either based on a proprietary or open blockchain but without the opportunity for customization. Lastly, businesses may offer supporting or supplementary services, e.g. consulting services. The dimension *market segment* comprises six options. Software developers are customers that use a given infrastructure, e.g. databases or platforms, to develop their own software. Thus, developers are typically no end-users, but are encouraged to sell their products afterwards. Big businesses are expected to be rather no end-users as the potentially posses the ability to develop and integrate applications based on existing infrastructures using their internal human resources. However, in principal they can be both, developers as well as end-users. Middle-sized to small-sized businesses are also expected to have development and integration capacities, at least to some extend. Business- or private end-users are characterized as passive users, meaning that they are not able or not willing to take on development or integration efforts. The government is also assumed to be a passive end-user. The option *value network positioning* comprises three options, whereas the value is created either ex ante, ex post or during a transaction, whereas a transaction is defined as a transfer of products or services across a technologically separable interface that links a consumer with a producer or service provider (Williamson, 1981). It is assumed that there also exist business models that comprise two or more options, e.g. if the value is created throughout the whole supply chain of a product. The dimension *revenue stream* can be divided into four options, where revenue is generated either on a transactional basis, by revenue sharing with strategically business partners, by the offering of licensing and consulting services or by charging of customers on the basis of a subscriptions or accounts. Based on the resulting morphological box, a typology of business models is developed and types are exemplified by the use of distributed ledger based businesses.

4.3 The Five Types of Distributed Ledger Based Business Models

By comparing all possible paths through the morphological box, types of business models are generated in the following, which is equivalent to step three and four of the typology building process.

BUSINESS MODEL 1: DATA INFRASTRUCTURE PROVIDER

The first type of business model derived from the morphological box is the *data infrastructure provider* (Table 6). One example of this type of business model is the German start-up BigchainDB. Typically these businesses provide a distributed ledger as mere database and decentralized storage, without allowing any further applications build on top of it and developed by external entities. By this, these businesses build on the increasing need for storage capacity, featuring high throughputs up to millions of transaction per seconds or higher, low latency as well as capacity of petabytes or more (Mcconaghy et al., 2016). Customers of *data infrastructure providers* comprise all kind of end-users, including the government as well as big businesses and small- to medium-sized business, using the database either with permissioned or permission-less access. In particular, the latter allows industry specific database solutions (Mcconaghy et al., 2016). Value is generated ex post, for example, by secure and transparent storage of transactional data, whereas revenue is generated via customer subscriptions or accounts, which is equivalent to renting a particular storage capacity and the conditions belonging.

Dimensions	***Options***					
Core Value Proposition	Infrastructure Provision	Platform-Based Development	Application-based Integration	Service/ Application Provision	Supporting/ Supplementary Services	
Market Segment	Software Developers	Big Businesses	Small and Medium-sized Businesses	Business End-Consumer	Private End-Consumer	Government
Value Network Positioning	Before Transaction	During Transaction	After Transaction			
Revenue Stream	Transaction-Based	Revenue Sharing	Licensing & Consulting	Subscription/ Account-Based		

Table 6. Business model type I: Data infrastructure provider

BUSINESS MODEL 2: DEVELOPMENT FACILITATOR

The second type of a distributed ledger based business model is the *development facilitator*, mainly responsible for platform-based development (Table 7). Examples of *development facilitators* are MultiChain, which is a software platform for the deployment of blockchain-based applications by offering special niche-database architecture as well as Symbiont, which is a smart contract platform.

Dimensions	***Options***					
Core Value Proposition	Infrastructure Provision	Platform-Based Development	Application-based Integration	Service/ Application Provision	Supporting/ Supplementary Services	
Market Segment	Software Developers	Big Businesses	Small and Medium-sized Businesses	Business End-Consumer	Private End-Consumer	Government
Value Network Positioning	Before Transaction	During Transaction	After Transaction			
Revenue Stream	Transaction-Based	Revenue Sharing	Licensing & Consulting	Subscription/ Account-Based		

Table 7. Business model type II: Development facilitator

According to the information provided by MultiChain, customers are enabled to treat the blockchain as a black box by using a platform (in the case of MultiChain a separate 'fork-chain' and a MultiChain-node), leading to reduced development efforts for blockchain applications. As the platform-based approach allows for the development of applications on top of the existing infrastructure, customers of *development facilitators* are software developers as well as big businesses that want to build distributed ledger solutions internally. Notably, the ability to build applications on top of the infrastructure divides *development facilitators* from *data infrastructure providers*. Moreover, customers may also be small- to medium-sized companies or start-ups that want to build blockchain applications as well as consulting companies that want to advise other companies with the development of blockchain based applications. Value creation typically happens before the actual transaction by providing the critical infrastructure and building the fundament for the realization of the transaction or ex post transaction documentation. Revenue generation is obtained by licensing as well as by subscription or based on an account, e.g. by 'renting' a fork chain as infrastructure for own development efforts. However, also consulting services are conceivable. MultiChain, for example, offers according to their own information, small-scale but high-priced consulting and wants to price service level agreements for live deployment in the future as well as premium versions with regular licensed software.

BUSINESS MODEL 3: INTEGRATION ENABLER

Integration enabler is the third type of business model, whereas the core value proposition mainly consists in services concentrated on application-based integration (Table 8). In contrast to the former business model *development facilitator*, there is no flexibility in regard to the offered product or service. *Integration enablers* rather offer particular applications located in a specialized application field and provide integration services of these applications suited to the needs and organizational aspects of a particular business. An example of an *integration enabler* is Factom, offering blockchain-enabled tools and services build on top of an open source blockchain. By this customers do not need to implement tools on their own and benefit from cost and time reductions due to reduced development and integration efforts. Factom states that the implementation of applications also leads to a reduction of the learning curve for customers that use the blockchain. Customers of *integration enabler* are all kind of businesses as well as end-consumers including the government or other public companies such as public infrastructure providers. Value is typically generated ex ante, as the service provided by these businesses is the basis for operational activities of customers, the associated transactions and the reporting of transactional data. Revenue stream result from licensing activities, as, for example in the case of Factom, tools are offered as Software-as-a-Service, leading to lower implementation barriers. Moreover revenue is generated from consulting services as well as from subscription or account-based pricing, if customers need to become a part of the network, e.g. in form of a node.

Dimensions	*Options*					
Core Value Proposition	Infrastructure Provision	Platform-Based Development	Application-Based Integration	Service/ Application Provision	Supporting/ Supplementary Services	
Market Segment	Software Developers	Big Businesses	Small and Medium-sized Businesses	Business End-Consumer	Private End-Consumer	Government
Value Network Positioning	Before Transaction	During Transaction	After Transaction			
Revenue Stream	Transaction-Based	Revenue Sharing	Licensing & Consulting	Subscription/ Account-Based		

Table 8. Business model type III: Integration enabler

BUSINESS MODEL 4: APPLICATION PROVIDER

The fourth type of business model is the *application provider* (Table 9). These businesses typically offer fixed applications without the possibility for customization. Examples of this type of business model are Fuzo, offering among others mobile phone remittance services, SETL, responsible for market transaction settlement as well as payment, and DXMarkets, which provides a trading platform for digital currencies. According to their core value proposition, the customers of *application providers* are mostly business and private end-users as well as the government. Customers can be described as passive users, since they are not interested in the integration of the distributed ledger technology within their own organizational structures or in independent development efforts. Value creation can happen ex ante or ex post as well as during the transaction, e.g. by offering a payment system. Lastly, the revenue stream for application providers can be based on a numerous pricing models and revenue streams including transaction-based pricing, revenue sharing with strategic business partners, licensing and consulting as well as via subscription and account-based.

Dimensions	Options					
Core Value Proposition	Infrastructure Provision	Platform-Based Development	Application-Based Integration	Service/ Application Provision	Supporting/ Supplementary Services	
Market Segment	Software Developers	Big Businesses	Small and Medium-sized Businesses	Business End-Consumer	Private End-Consumer	Government
Value Network Positioning	Before Transaction	During Transaction	After Transaction			
Revenue Stream	Transaction-Based	Revenue Sharing	Licensing & Consulting	Subscription/ Account-Based		

Table 9. Business model type IV: Application provider

BUSINESS MODEL 5: SUPPORTING OR SUPPLEMENTARY SERVICE PROVIDER

The fifth and last type of business model is the *supporting or supplementary service provider* (Table 10). An example of this kind of business model is the incubator and investor StringLabs, specialized on advanced decentralized protocols and applications. According to StringLabs, customers benefit from the professional experience and capital to build open protocol ventures for the realization of projects, such as decentralized commercial banking. Thus, costumers of String Labs might be entrepreneurs as well as small- to middle sized start-ups. Other supplementary services identified in this paper are organizations striving for the provision of information and pushing forward the public recognition of the technology (e.g. Blockchain University (2016)). Therefore, also businesses and private-end user are potential costumers of *supporting or supplementary services*. Given the variety of services that can be offered based on this type of business model, the value creation can happen before, after as well as during transactions. Except for non-profit organizations, *supporting or supplementary service providers* are able to generate revenue via revenue sharing as well as by offering consulting services.

Dimensions	Options					
Core Value Proposition	Infrastructure Provision	Platform-Based Development	Application-Based Integration	Service/ Application Provision	Supporting/ Supplementary Services	
Market Segment	Software Developers	Big Businesses	Small and Medium-sized Businesses	Business End-Consumer	Private End-Consumer	Government
Value Network Positioning	Before Transaction	During Transaction	After Transaction			
Revenue Stream	Transaction-Based	Revenue Sharing	Licensing & Consulting	Subscription/ Account-Based		

Table 10. Business model type V: Supporting or supplementary service provider

4.4 Implications of the Typology and Discussion of the Results

Given the five divergent business models and subsequent characterization it gets apparent that the emerged business models as such, are not new and already observed in other contexts, such as in the context of platform-based cloud solutions (Giessmann and Legner, 2016) or applications offered as a part of a software-as-a-service strategy (Weinhardt et al., 2009). However, two important implications can be derived that must be discussed in the context of prior research, concerned with business models in general and IT-enabled business models, specifically (e.g. Hedman and Kalling (2003), Al-Debei and Avison (2010) and Ojala (2016)). The first implication is that, so far, distributed ledger technology seems not to lead to an apparent disruption of existing business models. However, it must be considered that distributed ledger may shape business models in a more inconspicuous way, as existing business practices must be aligned to the technology leading to more varieties and rearrangement of existing social orders including the dynamic interplay between different corporate actors (Kuk and Janssen, 2013). Consequently, while business models might stay the same on the surface, actually they might get more explicit and flexible, owing to a increasing insecurities implied by the use of distributed ledgers as infrastructure facilitating digital interactions (Al-Debei and Avison, 2010; Ojala, 2016).

Related to this issue is the fact that technologies can take different roles according to Adomavicius et al. (2007), whereas roles may change depending on the business model the component of the business model that is affected by the technology (e.g. organizational activities and structures, resources, offering) (Hedman and Kalling, 2003). For instance, looking at the identified business models the role of the distributed ledger differs between platform-based solutions and applications. Whereas in the latter case, distributed ledger take on a product or application role, meaning that distributed ledger technology is the focal point and in direct competition with other, alternative technologies (e.g. other payment or remittance services in the case of Fuzo), applied as platform-based solution, distributed ledger rather functions as enabler for further component or application development. Consequently, the second implication is that depending on the role of the technology, a particular business model is shaped to varying degrees by the technology and with respect to the organizational structure and activities. For instance, distributed ledgers that are applied as digital infrastructure for the realization of an corporate-owned application, e.g. for supporting business activities such as accounting, may lead to a deconstruction of commonly applied roles within organizations, leading to the necessity to define new roles and responsibilities that differ from traditional hierarchical structures. More precisely, if distributed consensus is exemplarily applied for decision-making in the context of accounting, every validating node is then responsible for the correctness of a transaction and, consequently, also liable. The implied decentralization of responsibilities is in stark contrast to contemporary and predominantly applied management practices. The resulting third implication that eventually leads back to the first implication is, therefore, that given a product role of a distributed ledger, the consequences for business models may be significant and change the understanding of current business models and relationships, for instance given incompatibilities with existing business routines (Kuk and Janssen, 2013). The fact that these effects are not captured by the business model typification and characterization may reflect that the majority of analysed firms are still in the founding or product development phase, meaning that the effects of distributed ledger technology could not unfold so far, or unfold rather on an organizational level that is less considered by the identified business model key-features.

5 Conclusion and Outlook

This paper is a first step towards a more differentiated discussion on the potentials of distributed ledger technology by identifying five types of business models based on distributed ledger technology. Thereby, a focus is placed on a corporate perspective on distributed ledger technology use. It is suggested that future work should take this differentiation as a starting point in assessing the potential of the technology by investigate each type of business model isolated, given the large differences of options accompanied by the respective business models and the associated role of the technology. It must be noted that the generality of the identified business models is limited given the small number of evidence and answers provided by the companies. Thus the typology cannot claim completeness of business models or general transferability. Further efforts should be made in testing the validity of these models by using long-term market observations and further case studies. Potentially, this will reveal additional business models and leads to a more differentiated characterization of the models by extending the underlying morphological box. Further research should also concentrate on the simultaneously analysis of the underlying distributed ledger type and its contribution to the success of the particular business model. Lastly, the majority of businesses that are contacted in this study are in the finance industry or provide digital infrastructures. Even if this is not a proof of the possible potentials in these application fields, further research should put special attention on both application areas.

References

Adomavicius, G., Bockstedt, J. C., Gupta, A. and Kauffman, R. J. (2007). "Technology roles and paths of influence in an ecosystem model of technology evolution." *Information Technology and Management* 8(2), 185–202.

Afuah, A. and Tucci, C. L. (2001). *Internet Business Models*. New York: McGraw-Hill/Irwin.

Al-Debei, M. M. and Avison, D. (2010). "Developing a unified framework of the business model concept." *European Journal of Information Systems* 19(3), 359–376.

Alt, R. and Zimmermann, H.-D. (2001). "Preface: Introduction to Special Section - Business Models." *Electronic Markets* 11(1), 3–9.

Baden-Fuller, C. and Morgan, M. S. (2010). "Business models as models." *Long Range Planning* 43(2–3), 156–171.

Bitfury and Garzik, J. (2015). *Public versus Private Blockchains.* White Paper (initial version). Bitfury Group Limited.

Blockchain University (2016). *Blockchain University.* URL: http://blockchainu.co (visited on 11/10/2016).

Böhme, R., Christin, N., Edelman, B. and Moore, T. (2015) "Bitcoin: Economics, Technology, and Governance." *Journal of Economic Perspectives* 29(2), 213–238.

Brown, R. G. (2016). *Introducing R3 Corda: A Distributed Ledger for Financial Services.* URL: https://r3cev.com/blog/2016/4/4/introducing-r3-corda-a-distributed-ledger-designed-for-financial-services (visited on 28/10/2016).

Chakravarthy, B. S. and Doz, Y. (1992). "Strategy process research: Focusing on corporate self-renewal." *Strategic Management Journal* (13), 5–14.

Charmaz, K. (2006). Reconstructing Theory in Grounded Theory Studies." In: *Constructing Grounded Theory*, Ed. by Charmaz, K., Los Angeles, London: Sage, 123–150.

Chesbrough, H. and Rosenbloom, R. S. (2002). "The role of the business model in capturing value from innovation: evidence from Xerox Corporation ' s technology spin-off companies." *Industrial and Corporate Change* 11(3), 529–555.

Dolev, D., Dwork, C. and Stockmeyer, L. (1983). "On the minimal synchronism needed for distributed consensus." In: *Proceedings of the 24th Annual Symposium on Foundations of Computer Science* 34(I), 77–97.

Doty, D. H. and Glick, W. H. (1994). "Typologies as a Unique Form of Theory Building: Toward Improved Understanding and Modeling." *Academy of Management Review* 19(2), 230–251.

DXMarkets (2016). *DX Markets.* URL: https://www.dxmarkets.com (visited on 10/10/2016).

Evans-Greenwood, P., Hillard, R., Harper, I. and Williams, P. (2016). *Bitcoin, Blockchain & distributed ledgers: Caught between promise and reality*. Report. Deloitte Australia.

Fanning, K. and Centers, D. P. (2016). "Blockchain and Its Coming Impact on Financial Services." *The Journal of Corporate Accounting & Finance* 27(5), 53–57.

Giessmann, A. and Legner, C. (2016). "Designing business models for cloud platforms." *Information Systems Journal* 26(5), 551–579.

Gordijn, J. and Akkermans, H. (2001). "Designing and evaluating E-business models." *IEEE Intelligent Systems and Their Applications* 16(4), 11–17.

Hamel, G. (2001). "Leading the revolution." *Strategy & Leadership* 29(1), 4–10.

Hedman, J. and Kalling, T. (2003). "The business model concept: theoretical underpinnings and empirical illustrations." *European Journal of Information Systems* 12(1), 49–59.

Johnson, M. W., Christensen, C. M. and Kagermann, H. (2008). "Reinventing your business model." *Harvard Business Review* 86(12).

Kazan, E., Tan, C.-W. and Lim, E. T. K. (2015). "Value Creation in Cryptocurrency Networks : Towards A Taxonomy of Digital Business Models for Bitcoin Companies." In: *Proceedings of the 19th Pacific Asia Conference on Information Systems (PACIS)*, p. 16-34.

Keller, U. and Kluge, S. (1999). "Vom Einzelfall zum Typus," *Qualitative Sozialforschung*, 4. Ed. by Keller, U. and Kluge, S. Berlin, Heidelberg: Springer.

Kluge, S. (2000). "Empirically grounded construction of types and typologies in qualitative social research." *Forum: Qualitative Social Research* 1(1), art. 14. URL: http://www.qualitative-research.net/index.php/fqs/article/view/1124/2499%5Cnhttp://nbn-resolving.de/urn:nbn:de:0114-fqs0001145.%5CnRevised (visited on 10/10/2016).

Kuckartz, U. (2010) "Sozialwissenschaftliche Ansätze für die kategorienbasierte Textanalyse," *Einführung in die computergestützte Analyse qualitativer Daten*, Ed. by Kuckartz, K. Wiesbaden: VS Verlag, 72–107.

Kujala, S., Artto, K., Aaltonen, P. and Turkulainen, V. (2010). "Business models in project-based firms - Towards a typology of solution-specific business models." *International Journal of Project Management* 28(2), 96–106.

Kuk, G. and Janssen, M. (2013). "Assembling infrastructures and business models for service design and innovation." *Information Systems Journal* 23(5), 445–469.

Markides, C. C. (1999). "A dynamic view of strategy." *Sloan Management Review* 40(3), 55–63.

Mazières, D. (2016). *The Stellar Consensus Protocol: A Federated Model for Internet-Level Consensus.* White Paper, Stellar.

Mcconaghy, T., Marques, R., Müller, A., De Jonghe, D., Mcconaghy, T., Mcmullen, G., Henderson, R., Bellemare, S. and Granzotto, A. (2016). B*igchainDB: A Scalable Blockchain Database (DRAFT)*. White Paper. BigchainDB.

McMillan, A. and Jackson, N. (2015). B*lockchain - The Future of Finance, or the Next Tech Bubble?*, Simmons&Simmons. URL: http://www.tmtfinance.com/content/blockchain-—-future-finance-or-next-tech-bubble-simmons-simmons (visited on 12/10/2016).

Morris, M., Schindehutte, M. and Allen, J. (2005). "The entrepreneur's business model: Toward a unified perspective." *Journal of Business Research* 58(6), pp. 726–735.

Nakamoto, S. (2008). *Bitcoin: A Peer-to-Peer Electronic Cash System*. White Paper. URL: https://bitcoin.org/bitcoin.pdf (visited on 10/10/2016).

Ojala, A. (2016). "Business models and opportunity creation: How IT entrepreneurs create and develop business models under uncertainty." *Information Systems Journal* 26(5), 451–476.

Osterwalder, A. and Pigneur, Y. (2010). *Business Model Generation, A Handbook for Visionaries, Game Changers, and Challengers.* Hoboken: Wiley.

Peteraf, M. a (1993). "The cornerstones of competitive advantage: a resource based view." *Strategic Management Journal* 14, 179–191.

Pinna, A. and Ruttenberg, W. (2016). *Distributed ledger technologies in securities post-trading*. ECB Occasional Paper No. 172.

Porter, M. E. (1980). *Competitive Strategy: Techniques for Analyzing Industries and Competitors*. New York: Free Press.

Probst, L., Frideres, L., Cambier, B. and Martinez-Diaz, C. (2016). *Blockchain Applications & Services*. Business Innovation Observatory, European Commission Case Study 68.

Pugh, D. S., Hickson, D. J. and Hinings, C. R. (1969). "An Empirical Taxonomy of Structures of Work Organizations." *Administrative Science Quarterly* 14(1), 115–126.

Ritchey, T. (1998). "General Morphological Analysis: A general method for non-quantified modelling." In: *Proceedings of the 16th EURO Conference on Operational Analysis*, Brussels.

Seibold, S. and Samman, G. (2016). *Consensus: Immutable Agreement for the Internet of Value*. Report. KPMG.

Sixt, E. (2016). "Sonstige mögliche Anwendungsbereiche für dezentrale Transaktionssysteme," Ed. by Sixt, E., *Bitcoins und andere dezentrale Transaktionssysteme*. Wiesbaden: Springer Fachmedien, 187–188.

Taylor, M. B. (2013). "Bitcoin and the age of Bespoke Silicon." In: *Proceedings of the 2013 International Conference on Compilers, Architecture and Synthesis for Embedded Systems* (CASES 2013), Montreal, QB, 1-10.

UniqueID (2016). *UniqueID*. URL: http://uniquid.com (visited on 10/10/2016).

Valenzuela, J. (2016). *Will 2016's $300 Million Blockchain Startup Bubble Burst?*. URL: https://cointelegraph.com/news/will-2016s-300-million-blockchain-startup-bubble-burst (visited on 12/10/2016).

Vukolic, M. (2016). "The Quest for Scalable Blockchain Fabric: Proof-of-Work vs. BFT Replication." In: *International Workshop on Open Problems in Network Security*. Zürich, Switzerland: Springer International Publishing, 112–125.

Walport, M. (2015). *Distributed ledger technology: Beyond block chain*. Government Office for Science. London.

Weill, P. and Vitale, M. R. (2001). *Place to Space: Migrating to eBusiness Models*. Brighton: Harvard Business School Press Books.

Weinhardt, C., Anandasivam, A., Blau, B., Borissov, N., Meinl, T., Michalk, W. and Stößer, J. (2009). "Cloud Computing – A Classification, Business Models, and Research Directions." *Business & Information Systems Engineering* 1(5), 391–399.

Williamson, O. E. (1981). "The Economics of Organization: The Transaction Cost Approach." A*merican Journal of Sociology* 87(3), 548–577.

Wittpahl, V. (2016). *Digitalisierung: Bildung, Technik, Innovation*. Beriln, Heidelberg: Springer.

Yermack, D. (2015). *Corporate Governance and Blockchains*. National Bureau of Economic Research (NBER). NBER Working Paper No. 21802.

Zwicky, F. and Wilson, A. G. (1967). "New Methods of Thought and Procedure. Contributions to the Symposium on Methodologies." In: *Proceedings of the Symposium on Methodologies*, May 22-24, 1967, Pasadena, CA, 1–15. Berlin, Heidelberg: Springer.